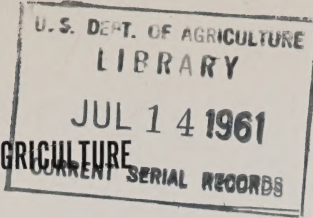


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Dwarfmistletoe of Douglas-fir

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Dwarfmistletoe (*Arceuthobium douglasii* Engelm.), one of the most destructive enemies of Douglas-fir, causes serious losses in many stands. This parasitic plant is present almost everywhere within the range of Douglas-fir in the northern, central, and southern Rockies. It is abundant in eastern Washington and Oregon and is common in southwestern Oregon and northern California. It does not occur in the Douglas-fir forests west of the Cascades and north of the Siskiyou Mountains of Oregon.

Douglas-fir is the principal tree affected by this dwarfmistletoe. True firs, and possibly an occasional spruce, are sometimes attacked by it, but on these species it is of no economic importance.

Symptoms of Infection

The most striking symptom of dwarfmistletoe infection on Douglas-fir is the formation of witches'-brooms, which are more or less spherical balls of abnormal branch and twig growth (fig. 1, A). These brooms may be confined to a single limb or may occur on numerous limbs throughout the tree. Old mature brooms sometimes attain immense size, often including the entire crown, and generally develop long drooping or trailing branches on their lower portions. Broomed branches have lighter colored and smaller needles than normal

branches do. Typical brooms generally form a few years after initial infection in trees of any age. Therefore, infection can usually be recognized even in lightly attacked trees.

Infected stands have an unsightly appearance because of trees with stunted growth, witches'-brooms, and dead tops. Often such stands also have an abnormal number of dead trees bearing the remnants of brooms (fig. 1, C). Some stands have only a few scattered trees infected, but stands with 50 to 100 percent of the stems attacked are much more common.

At the point of initial infection, branches swell and become spindle-shaped. These swellings may be either pronounced or rather inconspicuous. Trunk symptoms may develop from old established infections and are characterized by large elongated and flattened cankers on one or more sides of the trunk or by spindle-shaped swellings of the trunk. More frequently the trunk has a series of small individual burls. Each burl represents the point of an old infection from which the aerial parts of the parasite have disappeared.

Dead and dying tops (fig. 1, B) almost always appear in heavily infected Douglas-fir stands and are common in moderately infected stands. The heaviest infection in nearly all trees is in the lower part of the crown, where numerous brooms develop. Nutrients needed by the growing top of the tree are

¹ U.S. Department of Agriculture, Forest Service, Ogden, Utah.



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Figure 1.—*A*, A mature Douglas-fir with most of the live crown in a series of immense brooms. Note the young brooms and poor vigor in the upper crown. *B*, This Douglas-fir does not have a normal branch. All are broomed and the top is dead from lack of nourishment. Most young trees in the vicinity are infected. *C*, A Douglas-fir killed by dwarfmistletoe. Note structure of the old witches'-brooms.

probably diverted to the lower-crown brooms; this results in loss of vigor, and usually in death of the upper part of the crown.

Description

The Douglas-fir dwarfmistletoe is a small inconspicuous seed-bearing plant that establishes itself on the younger stems and branches of a tree (fig. 2). The aerial parts are slender, olive green, segmented shoots that rarely branch and are virtually leafless. These shoots arise at fairly regular intervals along young branches, from a root-

like network of absorbing strands imbedded in the host tissues. The male and female flowers, produced on separate plants in the spring, are very small and inconspicuous. They have somewhat the same color as the rest of the plant.

Life History

The berrylike fruit, which matures the second autumn after pollination, contains a single seed. When ripe, the berry drops from the plant; simultaneously the seed is shot into the air, often upward into the crown.

The seed is imbedded in a sticky, hygroscopic substance. This mucilaginous substance holds the seed fast to the surface on which it lands, and provides a moist medium for germination. Most seeds are probably dormant during the winter and germinate in the spring.



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Figure 2.—A, Mature female shoots and, B, mature male shoots of the Douglas-fir dwarfmistletoe.

Seeds that do not stick to the upper parts of the parent tree continue their flight outward to infect trees within range. This spread from tree to tree is principally from overstory to understory. Spread is probably at least twice as fast in open, uneven-aged stands as in dense, even-aged stands. The influence of height of seed-bearing plants, wind, and slope on distance and rate of seed dissemination is unknown.

Infection occurs most easily in 1- to 3-year-old twig growth, but older growth is sometimes attacked. The primary rootlet of the germinating seed forces its way into the living bark tissues, and establishes a system to absorb elaborated foods from the host. Many crops of aerial shoots may be produced from this initial infection.

The absorbing strands from each infection advance along the branch,

within the bark. Spread of this absorbing system is toward both the base and tip of an infected branch; growth toward the tip keeps pace with branch elongation. Once established, a dwarfmistletoe plant lives for many years, usually dying only when the host tree dies.

Damage

Dwarfmistletoe infection causes loss of vigor in the host tree; it also reduces height and diameter growth, shortens life expectancy, lowers timber quality, and increases susceptibility to other damage. These damaging effects result from the parasite's interference with normal physiological processes of the tree. The dwarfmistletoe plant, a parasite, takes food from the host tree; this reduces the amount of food available for tissue formation by the tree.

Trees of all sizes and ages are readily attacked. The parasite is often the major factor contributing to the death of mature trees, and it causes considerable mortality among seedlings and saplings.

Severely diseased stands result from a continued intensification of the parasite over a long period. Infected stands require a longer time to mature than normal stands do. Infected trees reaching maturity contain less volume than normal mature trees do, and the timber is of lower quality. When stands become infected at an early age, many of the trees never reach merchantable size.

Partially completed surveys in Arizona and New Mexico indicate that about one-half of the commercial Douglas-fir type in these States is infected. Recent surveys in two national forests in the northern Rocky Mountains show that more than 60 percent of the Douglas-fir stands are infected. These latter surveys also show that in infected merchantable stands 80 percent of the Douglas-fir sawtimber and 40 to

50 percent of the understory trees have dwarfmistletoe.

Control

In many local areas, profitable production of Douglas-fir timber depends upon control of dwarfmistletoe. Because the parasite causes considerable reduction in yield, control should be considered in all areas where the pest occurs.

The only practical control of dwarfmistletoe over large forested areas is through proper management and silvicultural treatment. Care must be exercised, however, lest the treatment do more harm than good. Cutting merchantable infected trees and leaving mature cull trees, infected seed trees, or infected young trees does not provide control. Frequently such treatment causes the parasite on the residual trees to develop even more vigorously and reproduction under and near infected trees may readily become infected.

The parasite can be eliminated from a stand by cutting or poisoning infected trees of all sizes. In moderately to heavily damaged stands, a clear-cut operation that kills or removes all infected trees often is necessary. To minimize invasion of dwarfmistletoe from uncut borders, the ratio of perimeter to area of clear cut should be as low as possible. Advantage should be taken of any natural barrier that occurs between the boundary of a clear-cut and the uncut stand.

Young stands that have originated following extensive complete burns are generally free of dwarfmistletoe. Regenerated partial burns that leave an open, infected

overstory may be infected throughout or have widely scattered centers of infection. In such centers, elimination of infected trees will protect the larger surrounding areas that are free of the pest.

Pruning, though sometimes not practical in large-scale forest management, can be effective in control. If trees are young, pruning can be economically effective in small infection areas and in areas where individual trees have high value, such as recreational and administrative sites. Prunable trees must have rather light infection that is concentrated in the lower part of the crown. Branches having dwarfmistletoe shoots within a foot of the main stem cannot always be effectively removed, because the absorbing strands may have reached the main stem. A series of two or three prunings may be necessary, because recently established infection, not having produced aerial shoots, may escape notice. The life and vigor of mature trees can be prolonged by removing large witches'-brooms from the lower part of the crown.

Possibilities of chemical or biological control are being studied. Biological control does not look promising, but it appears possible to develop a chemical that will kill the parasite without injuring the host. If such a chemical treatment is developed, its use could supplement silvicultural methods of control.

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